CHAPTER 4

FLEXIBLE PAVEMENT SUBGRADES

4-1. Factors To Be Considered.

The information obtained from the explorations and tests previously described should be adequate to enable full consideration of all factors affecting the suitability of the subgrade and subsoil. The primary factors are as follows:

a. The general characteristics of the subgrade soils such as soil classification, limits, etc.

b. Depth to bed rock.

c. Depth to water table (including perched water table).

d. The compaction that can be attained in the subgrade and the adequacy of the existing density in the layers below the zone of compaction requirements.

e. The CBR that the compacted subgrade and uncompacted subgrade will have under local environmental conditions.

f. The presence of weak of soft layers in the sub- soil.

g. Susceptibility to detrimental frost action.

4-2. Compaction.

The natural density of the subgrade must be sufficient to resist densification under traffic or the subgrade must be compacted during construction to a depth where the natural density will resist densification under traffic. Table 4-1 shows the depth, measured from the pavement surface, at which a given percent compaction is required to prevent densification under traffic. Subgrades in cuts must have natural densities equal to or greater than the values shown in table 4-1. Where such is not the case, the subgrade must be compacted from the surface to meet the tabulated densities, or be removed and replaced in which case the requirements for fills apply, or be covered with sufficient select material, subbase, and base so that the uncompacted subgrade is at a depth where the in-place densities are satisfactory. In fill areas, cohesionless soils will be placed at no less than 95 percent of ASTM D 1557 maximum density nor cohesive fills at less than 90 percent 0 ASTM D 1557 maximum density.

Table 4-1. Depth of Compaction for Select Materials and Subgrades (CBR ≤ 20).

Design index	Depth of compaction* for percent compaction shown, in.									
	Cohesive soils PI > 5; LL > 25					Cohesionless soils PI ≤ 5; LL ≤ 25				
	100	95	90	85	80	100	95	90	85	80
1	3	7	10	14	17	7	13	19	25	33
2	4	8	12	16	20	8	15	22	29	38
3	4	9	14	18	23	9	17	25	33	43
4	5	11	16	21	26	11	20	28	37	48
5	6	12	18	23	28	12	22	31	40	53
6	7	14	19	25	31	14	24	35	44	58
7	7	15	21	28	34	15	26	38	48	63
8	8	16	23	30	37	16	29	41	52	68
9	9	18	25	32	40	18	31	44	56	74
10	10	20	28	35	43	20	34	47	59	77

* Depth of compaction is measured from pavement surface.

4-3. Compaction Example.

An example illustrating the application of sub-grade compaction requirements is as follows:

a. Cohesion less subgrade. Assume a clean cohesionless sand and a design CBR of 18, with a natural in-place density of 90 percent of maximum density to beyond the depth of exploration of 6 feet. From table 4-1 for a design index of 5, it is found that 100 percent density must extend to a depth of 12 inches below the pavement surface. Below this depth, fill sections must be compacted to 95 percent maximum density throughout, and cut sections to 95 percent of maximum density to a depth of 22 inches below the pavement surface. The designer must decide from previous experience or from test-section data whether or not these percentages of compaction in cut sections can be obtained from the top of the subgrade. If they cannot, a part of the subgrade must be removed, the underlying layer compacted, and the material replaced, or the thickness of select material or subbase must be so increased that the densities in the uncompacted subgrade will be adequate.

b. Cohesive subgrade. Assume a lean clay, a design CBR of 7, and a natural in-place density of 83 percent of maximum density extending below the depth of exploration of 6 feet. Compaction of the subgrade from the surface would be impracticable with ordinary equipment beyond the 6- to 8-inch depth that could be processed; therefore, the minimum depth of cut would be limited by the in-place density. From table 4-1 for a design index of 5, it is found that the 83 percent in-place natural density would be satisfactory below depths of about 25 inches from the pavement surface. From CBR design curves (explained subsequently), the top of the subgrade will be 14.5 inches below the pavement surface; therefore, a zone 10.5 inches thick below the top of the subgrade requires treatment. The bottom 6 to 8 inches of this can be processed in place; so about 4 inches of material must be removed and replaced. Compaction to 95 percent of maximum density is required for all cohesive material that lies within 12 inches of the pavement surface. Since the subgrade does not fall within this zone compaction requirements in the replaced material should be 90 percent to conform to fill requirements, and the layer processed in place should be 85 percent of maximum density to conform to fill requirements.

4-4. Selection of Design CBR Values.

Flexible pavements may be designed using the laboratory soaked CBR, the field in-place CBR, or the CBR from undisturbed samples as described in MIL-STD-621A, Method 101. For the design of flexible pavements in areas where no previous experience regarding pavement performance is available, the laboratory soaked CBR is normally used. Where an existing pavement is available at the site that has a subgrade constructed to the same standards as the job being designed, in-place tests or tests on undisturbed samples may be used in selecting the design CBR value. In-place tests are used when the subgrade material is at the maximum water content expected in the prototype. Contrarily, tests on undisturbed samples are used where the material is not at the maximum water content and thus soaking is required. Sampling involves considerably more work than in-place tests; also, "undisturbed" samples tend to be slightly disturbed; therefore, in-place tests should be used where possible. Guides for determining when in-place tests can be used are given in details of the CBR test in MIL-STD-621A, Test Method 101.